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ABSTRACT

The effects of two components of formative evaluation (frequency of measurement and data utilization) were compared to isolate formative evaluation components which teachers might routinely use to monitor achievement in learning disabled students. Fifty-two learning disabled and educable mentally retarded elementary students enrolled in regular class programs and receiving reading instruction in a special education resource room were randomly assigned to either a pretest non-data-based change group, a daily measurement non-data-based change group, a daily measurement data-based group, or an untreated control group. Analysis of results of oral reading data supported daily measurement and data-based changes as effective components of formative evaluation. (Author)

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University of Minnesota

Research Report No. 10

FORMATIVE EVALUATION IN THE CLASSROOM: AN APPROACH TO IMPROVING INSTRUCTION

Phyllis K. Mirkin and Stanley L. Deno

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Institute for Research on Learning Disabilities

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I. Adequacy of Norm-Referenced Data for Prediction of Success

II. Computer Simulation Research on the Assessment/Decision-making/Intervention Process

III. Comparative Research on Children Labeled LD and Children Failing Academically but not Labeled LD

IV. Surveys on In-the-Field Assessment, Decision Making, and Intervention

V. Ethological Research on Placement Team Decision Making

VI. Bias Following Assessment

VII. Reliability and Validity of Formative Evaluation Procedures

VIII. Data-Utilization Systems in Instructional Programming

Additional information on these research areas may be obtained by writing to the Editor at the Institute.

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Abstract

The effects of two components of formative evaluation, (a) frequency of measurement and (b) data utilization, were compared in order to isolate formative evaluation components which teachers might routinely use to monitor achievement. Fifty-two learning disabled and educable mentally retarded students enrolled in regular class programs and receiving reading instruction in a special education resource room were randomly assigned to either (a) a pre-posttest non-data-based change group, (b) a daily measurement non-data-based change group, (c) a daily measurement data-based change group, or (d) an untreated control group. Analysis of results of oral reading data supported daily measurement and data-based changes as effective components of formative evaluation.

Formative Evaluation in the Classroom: An Approach to Improving Instruction

Recent regulations promulgated under the Education for all Handicapped Children Act of 1975, PL 94-142, require the development of an Individual Educational Program (IEP) which specifies annual and short-term objectives whenever a student is identified as requiring special education service. While logical arguments to support use of objectives in the development of educational programs have been proposed (Mager, 1962; Popham & Husek, 1969; Steiner, 1975; Tyler, 1950), empirical verification of the beneficial achievement effects of specifying objectives is lacking. Equal numbers of studies can be found in which significant and non-significant results are reported (Duchastel & Merrill, 1973; Hartley & Davies, 1976). A major factor in these equivocal results may be the lack of adequate evaluation procedures to assist teachers in effective decision making during the instructional program (Crutcher & Hofmeister, 1975).

Traditionally, educational evaluation has been oriented to placement and summative decision making. While psychologists and educational diagnosticians routinely use diagnostic testing procedures which have formative decision-making potential, these procedures are not the usual classroom practice. Review and reteaching are the usual instructional decisions and relate only to items missed in the post test. A study of teacher decision making by Zoharik (1975) supports this view. He found planning decisions regarding evaluation, diagnosis, and instructional strategies were made by fewer than one-third of the 194 teachers studied. Similar findings were previously reported by Goodlad and Klein (1974) and Popham and Baker (1970).

Formative evaluation is concerned with the evaluation of educational programs still in some stage of development (Scriven, 1967). Unlike

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placement and summative evaluation, formative evaluation is intended to lead to the improvement of instruction during the teaching process itself, by providing feedback to both teacher and student regarding objective mastery (Conroy, 1973; Popham, 1972; Snow, 1977; Sullivan, 1971; Sherman, Note 1).

While there is considerable agreement that the key to improved instruction and educational decision making by teachers may be formative evaluation procedures, the most effective components of a formative evaluation system have not been isolated or systematically compared (Sullivan, 1971). Sullivan recommends identification of precise objectives in initial planning and the development of a detailed system for monitoring and recording achievement of objectives as important to the success of a formative evaluation system. Important concerns remain, however, regarding (a) the frequency of test administration required to make appropriate decisions during the instructional program, and (b) the way in which the collected data are utilized.

Recommendations regarding frequency of measurement vary from the periodic pre-post measurement approach described by Van Etten and Van Etten (1976) as non-continuous measurement, to the direct and daily continuous measurement approach advocated by those who practice the technology of precision teaching (Alper & White, 1971; Haughton, 1971; Kunzelman, 1970; Lindsley, 1964; Lovitt, 1967; White & Haring, 1976; Haring & Lovitt, Note 2, Starlin, Note 3, White & Liberty, Note 4). It is argued by proponents of this view that only continuous measurement and analysis of performance permits the teacher to make changes in the program when it will be of the greatest benefit to the student (Starlin, 1971).

The issue of "data utilization" is also one which has not been adequately resolved with respect to formative evaluation. One solution has been to establish a set of rules which provides a standard method for daily program analysis (Liberty, Notes 5 and 6). The rules attempt to take the "guesswork" out of analysis of daily measurement data by providing guidelines with respect to the length of time an intervention should be maintained for individual programs. The rules are determined not only by the progress of the student but by the objective (aim) of the program as well. The rules add an important dimension to formative evaluation not addressed in the pre-posttest paradigm.

A limited number of studies is reported in the research literature where attempts have been made to systematically isolate effective components of a formative evaluation system. Jenkins, Mayhall, Peschka, and Townsend (1974) compared charted and non-charted feedback of daily measurement data to teachers and students and reported results which significantly favored the charted feedback group. Frumess (Note 7) compared different degrees of self-management when used with daily measurement and found significant differences favoring students who charted their own daily scores compared to students for whom there was no self-charting or teacher charting of performance.

In an investigation of daily measurement and decision rules, Bohannon (Note 8) compared teacher judgment as the predominant formative evaluation procedure with daily measurement and data decision rules; he reported results which favored students in the latter treatment. Of particular interest were findings which suggested that for eight of

the 23 students in the study one minute of daily measurement was sufficient to improve achievement, thus making it unnecessary for the teacher to use any decision rules to make program adjustments.

The present study further explored Bohannon's findings by contrasting student achievement under conditions of daily measurement and daily measurement with data decision rules. In addition, a third treatment was initiated in which pre-posttest measurement was the only formative evaluation procedure systematically implemented by the teacher. The research was designed to answer the following questions:

1. Does daily measurement increase student performance on objectives beyond that attained with pre and posttesting?
2. Does adding a data utilization component increase student performance on objectives beyond that attained with daily measurement alone?

Method

Participants

Fifty-two children in grades two through six who had been previously classified as learning disabled or educable mentally retarded participated in the study. The students were enrolled in regular class programs and were receiving daily reading instruction from 13 special education resource teachers in four metropolitan school districts in Minnesota.

Treatments

Four students were randomly selected from each resource teacher's existing caseload and randomly assigned to one of three experimental treatment groups or to an untreated control group. The 13 subjects

in each treatment group then received reading instruction which included one of three combinations of formative evaluation procedures: (a) pre-post measurement, non-data-based change (PPN), (b) daily measurement, non-data-based change (DMN), or (c) daily measurement, data-based change (DMD). Analyses of variance of pretest performances revealed no reliable differences between groups.

Instruments

Four types of data were used to analyze treatment effects. Measures of oral reading rate correct, oral reading rate incorrect, vocabulary meaning, and comprehension were obtained for all students both prior to and following treatment. The first three measures were derived from stories randomly selected from Levels Ib, IIb, and IIIb of the Power Builder Kits (SRA, 1963, 1969). Each student read orally for three minutes and was asked to define five words which had previously been randomly selected from the first 100 words of the story. The total number of words read correctly and incorrectly were then counted and divided by three to obtain the per minute rate. The total number of words defined correctly was determined by teacher judgment. When in doubt, the first definition in the dictionary was used as the criterion. A measure of each student's reading comprehension was obtained using the Stanford Diagnostic Reading Test Level I, Forms W and X (1968) and the comprehension subtest of the Stanford Diagnostic Reading Test, Level II, Forms W and X (1966). Daily measures of oral reading correct and incorrect and vocabulary meaning in the SRA Power Builder Stories also were obtained for students in the daily measurement and data decision rule groups (N = 26).

Specific Procedures

All subjects initially were placed for reading instruction by the experimenter in three levels of the SRA Power Builder Kits (1963, 1969). Placement was determined by identifying passages which the student could read orally at the rate of 50 to 75, 35 to 60, and 30 to 40 words correctly per minute.[1] Error performance was not used in making the placement decision.

Each student's oral reading performance was then measured for three days at each of the three levels to reliably establish initial performance. A 30 percent increase in oral reading rate correct was arbitrarily established as the 18-day objective for all students in the experimental treatments. The desired level at 18 days was determined by multiplying the median initial oral reading correct score at each level by a factor of 1.3. To establish daily objectives for the daily measurement and data decision rule groups, a straight increasing daily aim line was drawn on an equal interval graph connecting the median initial level with the desired level at 18 days (Liberty, Notes 5 and 6). The daily objective for error rate was to remain at or below the median initial error rate. This objective was shown on the equal interval graph by drawing a straight line across the graph at the student's initial median error rate for each level. An example of a graph with initial data points and daily aim line drawn for both correct and error rates is shown in Figure 1.

- -

Insert Figure 1 about here

- -

The sequence of instructional activities for all groups was as follows:

Each student received 20 minutes of reading instruction daily from the special education resource teacher. Instruction consisted of reading nine stories twice at each level over an 18-day period. Students read aloud for three minutes at each of the three placement levels. Students were then asked to define five words from each story. Error correction and word meaning correction were given.

Each of the treatment groups differed from one another with respect to the daily formative evaluation procedures used as follows:

Daily Measurement, Data-based Change (DMD): The teacher and student reviewed the graph each day to determine whether the daily objective had been achieved. If daily data points were plotted below the aim line for two consecutive data days, a new aim line was drawn parallel to the original line (i.e., the target date was extended) and a program change was made. If the daily data points were plotted above the daily aim line for five consecutive days, a new daily aim line was drawn parallel and above the original line and a program change was made. Examples of original and redrawn daily aim lines are shown in Figure 2.

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Insert Figure 2 about here

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Error data were also reviewed daily. If daily data points were plotted above the median error line for two data days, a new median error line was drawn and a program change was made. If error data were plotted below the median line for five days, the same procedure was followed.

The teachers made a series of program changes as a function of the student's performance. The changes were, in sequence:

1. Each day a data point was plotted on or above the line the student received a gum ball dispensed by placing a penny supplied by the teacher in a gum ball machine.
2. Each day a data point was plotted on or above the line the student received a gummed sticker of his/her choice.
3. Each day a data point was plotted on or above the line the student received a gummed dot which was placed on a card. Five dots could be exchanged for a tangible item such as a book folder, an opportunity to work in the office or operate the audiovisual equipment, or any other similar school activity based on individual interest.

Daily Measurement Non-data-based Change (DMN): Following timed oral reading, teacher and student marked the graph and checked to see whether the daily objective had been achieved. Teachers provided encouragement with positive statements and praise. Whenever program changes were implemented for the (DMD) group, they were also implemented for this group.[2]

Pre-post Measurement Non-data-based Change (PPN): Following daily oral reading teachers praised students and thanked them for reading. Whenever program changes were implemented for the DMN group, they were also implemented for this group.[2]

Untreated Control Group (UC): This group came to the resource room daily for regular reading instruction of approximately the same duration (20 minutes) as the experimental groups. No controls were

exerted over the reading instruction of students in this group.

Immediately following the 18-day instruction period, the oral reading fluency and vocabulary meaning performance of all students was again measured on three days at each of the three levels in which initial performance was obtained. On the third day, a measure of reading comprehension was also obtained using the Stanford Diagnostic Reading Test Level I Form W (1968) for students in grades two and three and the Stanford Diagnostic Reading Test, Level II Form W (1968) for students in grades four through six.

Results

The post treatment data for all groups on all measures appear in Table 1. One way analyses of variance were conducted on the posttest means and are shown in Tables 2 and 3.

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Insert Tables 1, 2, and 3 about here

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As can be seen, the differences among group means obtained following treatment were reliable at Independent and Frustration Levels for the oral reading correct measure, but not for the other dependent measures. A post hoc analysis using a Student-Newman-Keuls procedure was conducted and is presented in Table 4.

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Insert Table 4 about here

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The results of the paired comparisons revealed that the DMD group performance exceeded the other three groups at both Frustration and

Independent Levels with one exception. The performance of the DMD group was apparently equal to that of the DMN group at the Independent Level. The post hoc analysis also revealed a difference between DMN and the UC group at the Independent Level.

Discussion

The results of the present study provide evidence that variations in teacher measurement practices and in how measurement data are used to make program decisions can significantly influence student performance. Several noteworthy conclusions concerning formative evaluation are supported by the obtained data.

First, not surprisingly, alterations in formative evaluation procedures seem to impact most directly the behavior which is measured and used as the datum for instructional decision making. In this research, teachers measured oral reading rate, used that data to make changes in the daily oral reading rate goals, and in whether or what consequences were delivered for achieving those daily oral reading goals. In addition teachers recorded student performance on vocabulary meaning, but set no daily objective for this behavior and did not use vocabulary meaning data to make program changes. The results were that treatment effects were revealed in the oral reading correct data but not in the vocabulary meaning data nor in the standardized comprehension measure. The fact that treatment effects were not revealed in oral reading errors weakens support for the conclusion that formative evaluation impacts most directly the measured behavior. Given that error rates were low across all three reading levels, and that the daily aim for errors was essentially to maintain initial error rates, however, it is not surprising that the

initial equivalence among treatment groups for this behavior remained at post testing. The practical significance of this first conclusion rests on the fact that formative evaluation requires that data be obtained on some particular behaviors. If the advantage of formative evaluation accrues primarily to the measured behavior, then considerable importance must be invested in decisions regarding what behaviors to measure.

A second conclusion regarding the effective components of formative evaluation which may be derived from the present results is that traditional pre and posttesting on a particular objective does not contribute to improved achievement. Students whose performance in oral reading was measured initially and again at the end of treatment increased no more than students in the untreated control group. That finding is made all the more remarkable by the fact that the students in the pre and post test treatment actually systematically practiced oral reading each day while the students in the untreated control group did not. The importance of this failure of pre and posttesting as an approach to formative evaluation is that it calls into question the purpose of the most pervasive informal approach used by teachers to monitor student achievement.

The third notable conclusion supported by the data analysis is that daily measurement of behavior specified in an objective will not consistently raise performance beyond no testing at all, and will not improve formative evaluation procedures beyond what is obtained by pre and posttesting. Student performance in oral reading in the daily measurement condition exceeded that of the untreated control group at the independent reading level but not at the frustration reading level. In none of the

comparisons did the mean oral reading performance of students measured daily exceed that of the pre-post testing group. Since students in the daily measurement treatment did receive performance feedback through daily inspection of their graphs and goals this finding is surprising and inconsistent with the results obtained by other researchers (e.g., Jenkins, Mayhall, Peschka, & Townsend, 1974). One may speculate that the difference between their results and those reported here may be due to the differences in procedures and emphasis given to the daily feedback on the part of both student and teacher. The failure of daily measurement and charting to consistently increase student achievement is important on efficiency grounds. Daily measurement and charting is time consuming. If daily measurement is to be included as a component of formative evaluation, its role in increasing student performance should be demonstrated.

The most important conclusion which may be supported by the results of the present study is that systematic formative evaluation most effectively contributes to student achievement when rules for the utilization of measurement data are included as part of the formative evaluation system. When teachers measured student oral reading performance daily in relation to daily goals and altered both goals and consequences contingent upon measured student performance relative to goals, superior achievement occurred. It should be recalled that students in the daily measurement treatment received exactly the same number and type of program changes, on the same schedule, as students in the data-utilization treatment, yet, in only one case did their performance exceed even the untreated control group. In contrast, the data-utilization group exceeded the untreated control and the pre-posttest group at both Frustration and

Independent reading levels, and exceeded the daily measurement group at Frustration Level.

We need to take note that the data utilization treatment was a complex treatment. The separate effects of daily measurement, and rules for altering goals and delivering consequences cannot be determined. Teachers may be able to efficiently alter goals and deliver consequences if they are not required to use the particular data-utilization rules employed in the present study, or if they are not required to measure daily. Our position is, however, that implicit in formative evaluation is a determinate relation between measurement data and program changes, and that formative evaluation consistently improves as improvements are made in measurement and the procedures for utilizing measurement data. The present results, we believe, support the conclusion that daily measurement of student performance is an important component of formative evaluation only when procedures for utilizing daily performance data are required.

A final comment regarding measuring student performance in reading for purposes of formative evaluation should be made. One may argue that oral reading rate in the basal reader is of questionable importance as an educational objective. Evidence is available to the contrary, however. Oral reading as a measure of decoding skill is highly related to reading achievement and to comprehension (Deno, Chiang, Mirkin, & Lowry, Note 9). Oral reading performance, then, serves as a convenient index of reading proficiency. An interesting finding in the present study is that oral reading at Independent and Frustration Levels was more sensitive to treatment effects. It may be that formative evaluation of reading requires regular measurement on content external to daily

instruction. Further research on what to measure as a part of formative evaluation in reading is required.

The conclusions presented here are limited, of course, by the design of the study. The only content used was reading, and only a limited set of variations in measurement and data utilization procedures was employed. Such is the nature of an experiment, and we would prefer to consider each of our conclusions as hypotheses requiring extensive testing with different subject matters, students, teachers, and, especially, with variations in formative evaluation procedures.

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Footnotes

[1]The oral reading rates used to initially place students correspond to the lower end of the independent, instruction and frustration level rates recommended by Starlin (1973) when making placement decisions for primary and intermediate grade remedial students.

[2]Since the data decision rule treatment requires a program change whenever a student does not achieve the daily objective for two consecutive data days, program changes were also implemented for students in the other experimental groups to control for the possibility that differences in performance could be attributed to the program changes rather than to the formative evaluation procedures.

Table 1

Posttest Means and Standard Deviations for Each Group by Level on Four Dependent Measures

	Group							
	PPN		DMN		DMD		UC	
	$\bar{X}$	sd	$\bar{X}$	sd	$\bar{X}$	sd	$\bar{X}$	sd
Oral Reading Correct								
Independent	70.69	12.48	75.62	8.43	82.77	13.15	63.85	11.92
Instruction	56.46	10.23	56.23	10.01	61.92	9.11	53.31	8.64
Frustration	40.00	6.89	38.69	6.37	46.23	7.29	38.54	4.03
Oral Reading Incorrect								
Independent	3.37	1.61	2.09	1.36	2.87	1.96	3.89	4.20
Instruction	4.92	1.42	4.06	1.57	4.65	2.29	4.50	4.23
Frustration	6.71	1.57	5.60	2.20	6.28	2.56	6.94	3.86
Vocabulary Meaning								
Independent	78.46	19.08	76.92	35.45	92.31	10.13	86.15	17.10
Instruction	55.38	30.72	63.08	29.26	69.23	27.83	63.08	25.62
Frustration	27.69	20.88	34.62	27.87	36.92	24.28	33.85	30.97
Comprehension	44.70	15.81	49.30	21.31	53.17	23.38	46.08	18.38

Table 2

Summary of the Analyses of Variance on Posttest Means for Three Dependent Variables

		Independent Level			Instruction Level			Frustration Level		
		MS	F	P	MS	F	P	MS	F	P
Oral Reading Correct										
Source	df									
Groups	3	828.46	6.11	.001	167.92	1.85	.15	171.92	4.37	.008
Error	48	135.50			90.57			39.38		
Total	51									
Oral Reading Incorrect										
Source	df									
Groups	3	7.63	1.18	.32	1.66	.24	.86	4.50	.63	.60
Error	48	6.48			6.91					
Total	51									
Vocabulary Meaning										
Source	df									
Groups	3	664.10	1.32	.28	417.95	.52	.67	201.92	.29	.83
Error	48	503.85			807.69			690.38		
Total	51									

Table 3

Summary of the Analysis of Variance on

Posttest Means for Comprehension

Source	df	MS	F	P
Group	3	179.32	.45	.72
Error	47	397.52		
Total	50 [a]			

[a] Data for one subject are missing.

Table 4

Contrasts on Posttest Means Oral Reading Rate Correct

Independent and Frustration Levels Using Student-Newman-Keuls Procedure

		Frustration Level			
Group	Mean	DMD	PPN	DMN	UC
DDM	46.23				
PPN	40.00	*			
DMN	38.69	*			
UC	38.54	*			

		Independent Level			
Group	Mean	DMD	DMN	PPN	UC
DMD	82.77				
DMN	75.62				
PPN	70.69	*			
UC	63.85	*	*		

*p = .05

Figure 1

A GRAPH WITH BASELINE DATA POINTS AND DAILY AIM LINES DRAWN; ORAL READING RATE CORRECT AND INCORRECT.

ORAL READING CORRECT OBJECTIVE: 55 words/minute

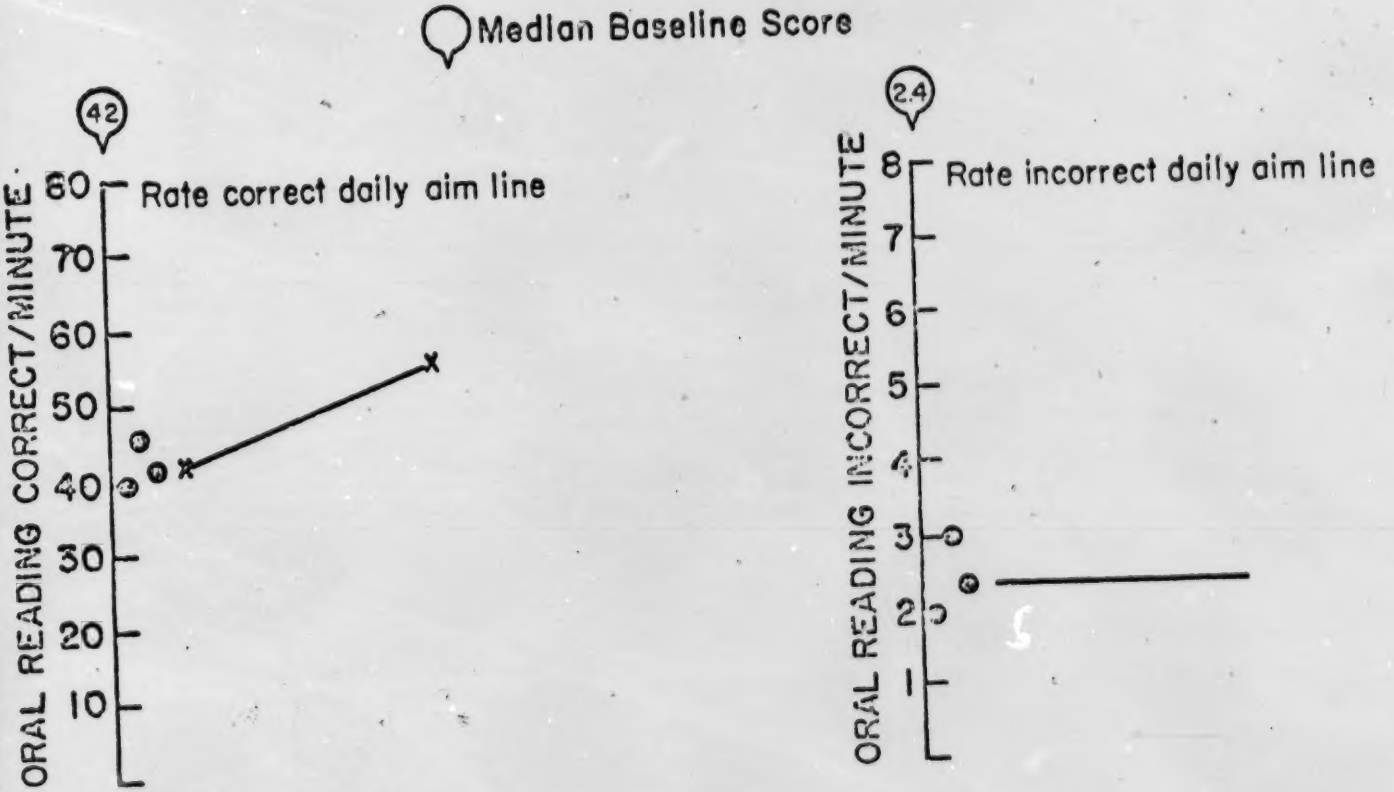
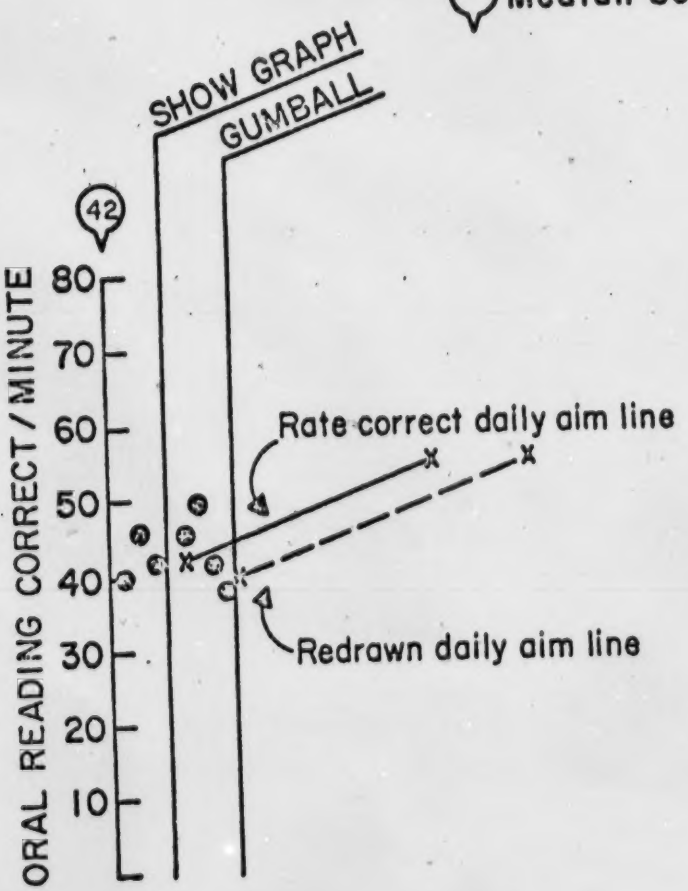


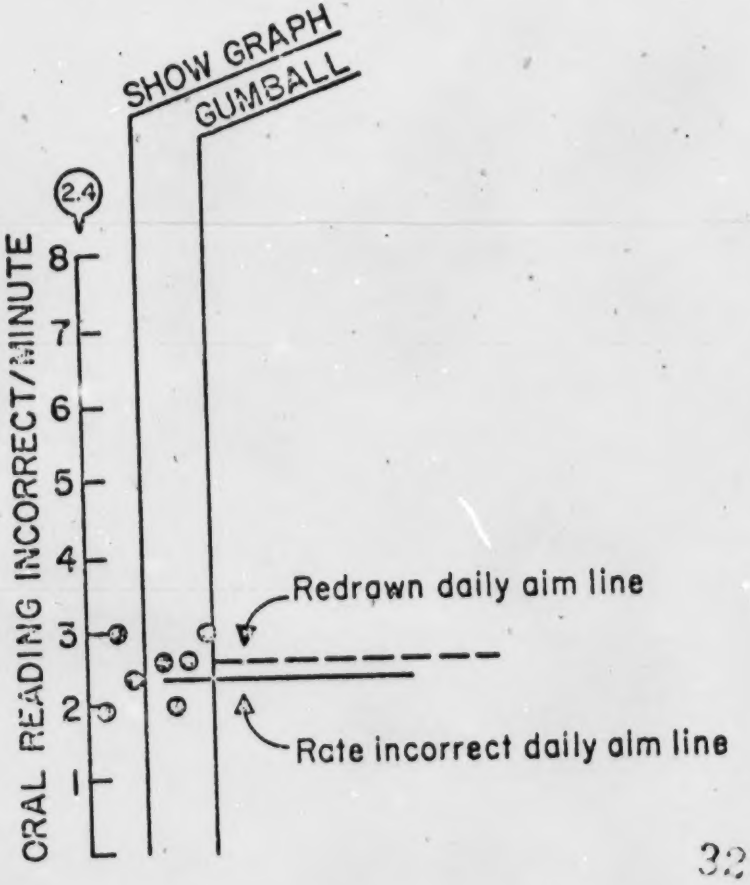
Figure 2

ORIGINAL AND REDRAWN DAILY AIM LINES

ORAL READING CORRECT OBJECTIVE: 55 words/minute

Median Score





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Ysseldyke, J. E. Assessing the learning disabled youngster: The state of the art (Research Report No. 1). November, 1977.

*Ysseldyke, J. E. Research and development plan: University of Minnesota Institute for Research on Learning Disabilities (Monograph No. 1). June, 1978.

*Ysseldyke, J. E., & Thurlow, M. L. (Eds.). Synthesis of the knowledge base: Identification and assessment of learning disabled children (Monograph No. 2). June, 1978.

*Ysseldyke, J. E. Organizational plan for Minnesota's Institute for Research on Learning Disabilities (Monograph No. 3). June, 1978.

*Ysseldyke, J. E., & Thurlow, M. L. Specific investigations to be completed during years two and three (Monograph No. 4). June, 1978.

*Ysseldyke, J. E., & Thurlow, M. L. Training opportunities at Minnesota's Institute for Research on Learning Disabilities (Monograph No. 5). June, 1978.

*Ysseldyke, J. E. Client base (Monograph No. 6). June, 1978.

Ysseldyke, J. E., & Regan, R. R. Nondiscriminatory assessment and decision making (Monograph No. 7). February, 1979.

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*As part of its continuation proposal, the Institute was required to prepare these monographs. Because they are part of the proposal, they are not available for general distribution.

**Thurlow, M., & Ysseldyke, J. Assessment in the child service demonstration centers for learning disabled children (Research Report No. 2). March, 1979.

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Jenkins, J. R., Deno, S. L., & Mirkin, P. K. Measuring pupil progress toward the least restrictive environment (Monograph No. 10). August, 1979.

Mirkin, P. K., & Deno, S. L. Formative evaluation in the classroom: An approach to improving instruction (Research Report No. 10). August, 1979.

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Thurlow, M. L., & Ysseldyke, J. E. Current assessment and decision-making practices in model programs for the learning disabled (Research Report No. 11). August, 1979.

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